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(54) Double-walled cellular plate

(57) A double-walled plate, of the cellular type, made of thermoplastics, transparent or opaque material, comprising two parallel walls (1, 2) spaced from each other by at least one partition, shaped so as to provide a series of sides (3) inclined with respect to the planes of the opposing walls (1, 2), the inclined sides of the partition defining a series of adjacent cells (5, 6, 7, 8) of substantially three sided transversal cross-section.

The partition may be of zig-zag configuration wherein the sides thereof have a constant angular inclination of 30° to 60° with respect to the planes of the opposing walls, or alternatively may consist of arched surfaces facing one of the opposing walls and having a radius of one to two times the total thickness of the plate.

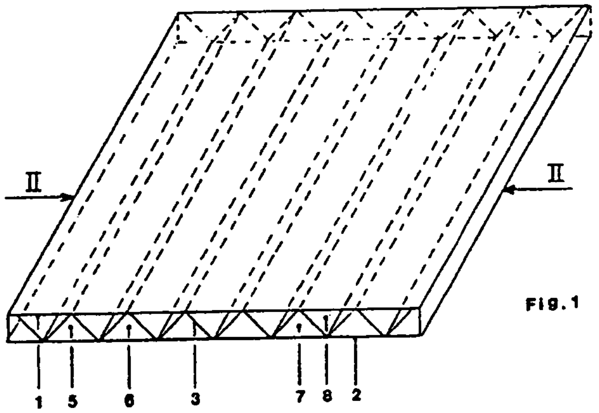

Fig. 1

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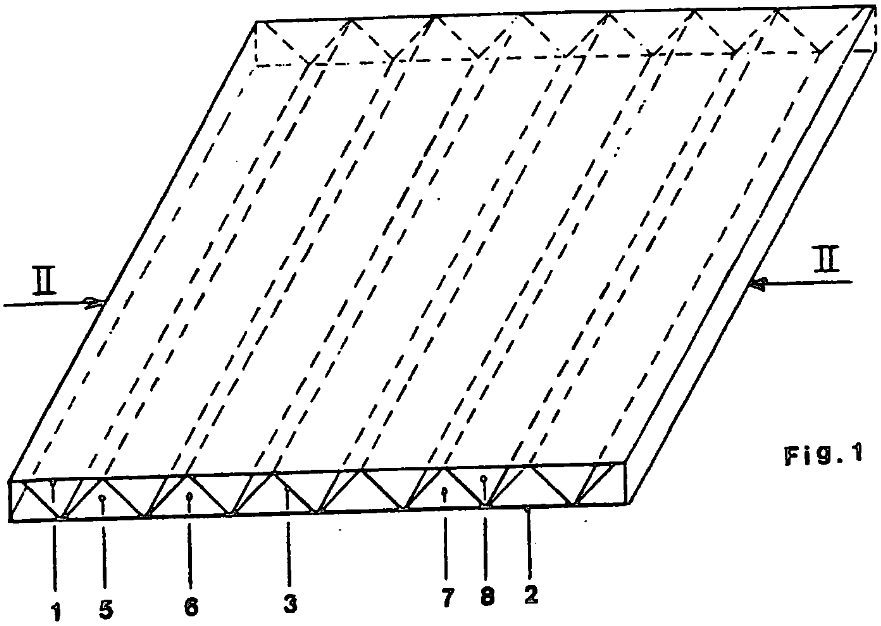

Fig. 1

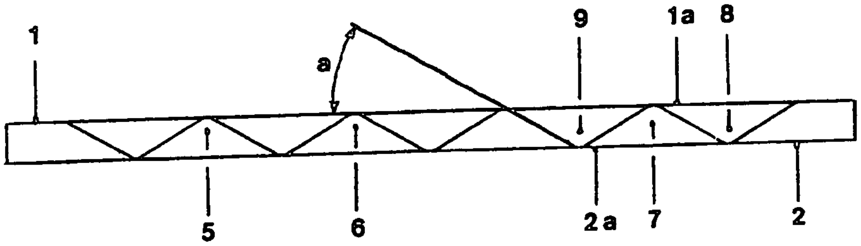

Fig. 2

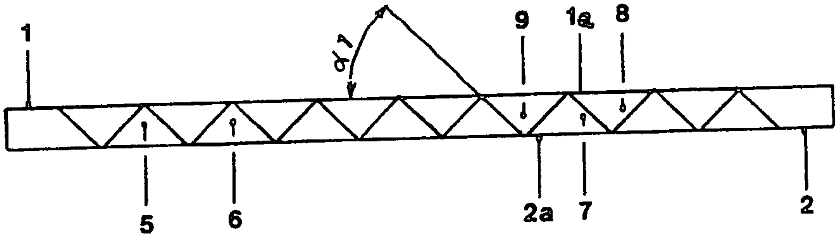

Fig. 3

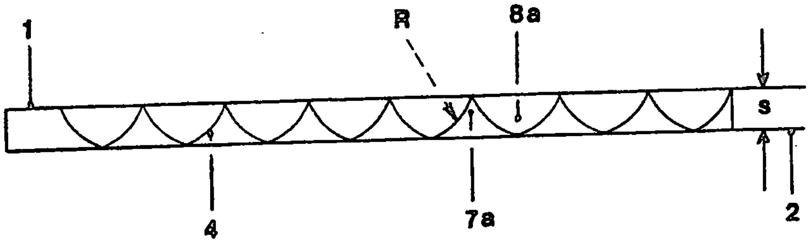

Fig. 4

SPECIFICATION

Double-walled cellular plate

The present invention relates to a double-walled cellular plate, made of thermoplastics material, and having high thermal insulating properties and a considerable rigidity (stiffness) and mechanical resistance, so as to be suitable for creating an effective thermal insulation in many applications and in particular in the building industries, particularly of greenhouses for vegetable and fruit growing.

More particularly, the invention relates to a double-walled cellular plate made of a material which may be transparent to light, and which provides, together with a high degree of thermal insulation, an almost complete transmission of luminous energy.

There are already known transparent plates, particularly made of polymethylmethacrylate and other materials, having a double wall structure in which the two external walls are maintained parallel to each other by a series of perpendicular, equidistant partitions, which form a series of adjacent cells which are substantially rectangular in transverse cross-section.

These types of double-walled plates with cells defined by partitions perpendicular to the opposing walls in practice do not offer a high degree of thermal insulation in as much as the partitions, being perpendicular to the walls of the plate, do not constitute interrupting or sub-dividing means for the opposite walls with regard to each other; in fact, the cells do not provide means for insulating or separating the opposite walls of the plate in respect of the thermal transmission.

The present invention provides a double-walled plate, of the cellular type, made of thermoplastics, transparent or opaque material, comprising two parallel walls spaced from each other by at least one continuous separating partition, shaped so as to provide a series of sides inclined with respect to the planes of the opposing walls, the said inclined sides defining a series of adjacent cells of substantially triangular transversal cross-section.

Thus there is provided a double-walled plate, of the cellular type, which comprises two flat walls kept spaced from and parallel to each other by a continuous separating partition with inclined sides, which may be rectilinear and/or curved, for example arched or in the form of an undulated plane, dimensioned in such a way as to define a series of adjacent cells which are substantially triangular in transversal section, the double-walled cellular plate being obtained by direct extrusion according to a conventional technique.

More particularly, when the partition has inclined sides, being arranged generally in the form of a zig-zag, all the inclined sides of the partition may have a constant inclination of from 30° to 60° with respect to the planes of the opposing walls of the plate, while when the sides of the partition are curved, for example, arched, the curved surfaces may have a bending radius of from one to two times the total thickness of the plate.

Moreover, both the walls of the plate as well as the partition are made of thermoplastics material of the opaque and/or transparent type, depending on the intended use of the plate.

The invention will be further described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of a double-walled plate of the cellular type according to the present invention;

Figure 2 is a transversal cross-section taken along the line II—II in Figure 1;

Figure 3 is a cross-sectional view of another type of plate similar to that of Figure 2; and

Figure 4 is a transversal sectional view of a further type of double-walled plate according to the present invention.

With reference to all the figures, the cellular plate according to the invention comprises two walls 1 and 2, kept spaced apart in a parallel relation to each other by a continuous separating partition, which in Figures 1, 2 and 3 is a partition 3 of zig-zag configuration, while in Figure 4 a partition 4 has an undulating configuration, with the curved sides all on the same side and all having the same bending radius.

The continuous separating partition 3 substantially extends over the whole inside area between the walls 1 and 2. The angle of inclination α between the inclined sides of the partition and the plane of the walls may vary, practically, from 30° to 60°. In Figure 2 the angle α indicates an angle of 30° formed between the sides of the partition the walls 1, 2, while the angle α' in Figure 3 indicates a similar angle of inclination of 45°.

Between the inclined sides of the partition 3 and the walls 1 and 2 there are thus formed a series of adjacent cells 5, 6, 7, 8 etc., which will thermally insulate (that is separate thermally from each other) portions of wall 1 from the corresponding portions of wall 2. In fact, each pair of cells, for instance cells 7 and 8, which are adjacent to wall portions 1*a* and 2*a*, separate the two opposing wall portions in as much as the cells 7, 8 themselves are separated from each other by an inclined side of the partition 3.

Also in the case of a partition 4 with arched sides (Figure 4), the adjacent cells 7*a*, 8*a*, since they are separated by one arched side of the partition, insulate thermally the corresponding portions of opposite walls.

In practice it has been found that, in the case of double-walled plates with a separating partition with arched sides, such as in Figure 4, in order to obtain the best possible insulating effect between the opposed walls, the bending radius R of the single curved sides is preferably from one to two times the total thickness S of the double-walled plate.

The continuity of the separating partition 3 (or 4), which allows one wall 1 to be thermally insulated from the other wall 2 (inasmuch as the adjacent cells are separated from each other by one side of the separating partition itself, makes the double-walled plate thus obtained particularly suited for the heating of greenhouses and the like. In fact, by conveying a hot fluid through the lower cells (e.g. through cells 5, 6, 7 etc.) there is obtained a heating practically only of the lower wall 2, while the upper wall remains thermally insulated by the presence of the adjacent cells 8 and 9 (Figures 2—3) where there is no circulation of hot fluid.

Best results, as far as thermal insulation of the opposing walls is concerned, are obtained practically with the double-walled plate of Figure 4, that is with the opposing walls spaced from each other by a continuous partition with arched sides.

The structure thus obtained, besides the advantages concerning the thermal insulation of opposing walls, has a considerable rigidity or structural stiffness and mechanical resistance with a high degree of uniformity (isothropy) in the two senses parallel and orthogonal to the arrangement of the separating partition.

The inclined arrangement of the partition sides allows a homogeneous transparency to be achieved also for a wide range of variations of the light incidence angle, when the walls and partition are made of transparent material.

The plate according to the invention may be suitably manufactured by direct extrusion through an extrusion head shaped to meet the pre-established geometry of the structure.

The total thickness of the plate, the thicknesses of the different elements (walls and separating partition), and the angulation of the partition may vary as a function of the overall characteristics required for the plate.

The plate may be manufactured optionally by using a single thermoplastics resin or by coupling the elements thereof with each other by co-extrusion (for instance making the walls of one type of material and the separating partition of a different material), having regard to the manufacturing cost and required performance.

In the case of transparent cellular plates, suitable materials are polymethacrylate, polycarbonate, polyvinylacetate and polyvinylchloride.

The double-walled plates thus obtained may find application in all those fields in which are required high thermal insulation, good rigidity and good transparency.

More particularly, the most commonly used applications may comprise:

— industrial roofings and windowing, both fixed and openable;

— perimetral enclosures for industrial sheds and other buildings;

— roofings in general (staircases, inner court-yards, etc.);

— interior transparent partitions;

— perimetral coverings and enclosures of greenhouses for horticultural, floricultural and fruit cultivation; and

— various coverings, for which there is required a forced circulation of heat-stabilizing fluids, or in the case of screenings in general.

CLAIMS

1. A double-walled plate, of the cellular type, made of thermoplastics, transparent or opaque material, comprising two parallel walls spaced from each other by at least one continuous separating partition, shaped so as to provide a series of sides inclined with respect to the plane of the opposing walls, the said inclined sides defining a series of adjacent cells of substantially triangular transversal cross-section.

2. A plate as claimed in Claim 1, wherein the inclined sides of the said partition consist of flat surfaces having a constant angular inclination of from 30° to 60° with respect to the planes of the two opposing walls.

3. A plate as claimed in Claim 1, wherein the inclined sides of the said partition consist of arched surfaces with their concavities facing one of the opposing walls, the said arched surfaces having a bending radius of from one to two times the total thickness of the double-walled plate.

4. A plate as claimed in any of Claims 1 to 3, wherein the opposing walls as well as the said partition are made of a single material.

5. A plate as claimed in any of Claims 1 to 3, wherein the opposing walls are made of a different thermoplastics material than that of the said partition.

6. A double-walled plate according to Claim 1, substantially as herein described with reference to, and as shown in, Figures 1 and 2, Figure 3 or Figure 4 of the accompanying drawings.

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